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H1Q CXEC

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None

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G2J
H1Q
Selected US specifications from IPC sub-classes G02B H01Q

(54) Curved reflector having zones with different focal points

(57) A dual-mode signal separator 10 has a single reflector 12 fabricated with two or more zones 14,18 of different radii of curvature, the different zones 14,18 of the reflector providing focal points 16,20 at different distances along an optical axis 11 of the reflector through the centre thereof. The different zones may be fabricated into concentric rings, concentric spirals, flat segments or other types of surfaces for providing the different focal points along the optical axis. The separator may receive infrared, millimetre, radio frequency, ultraviolet or other wavelengths.

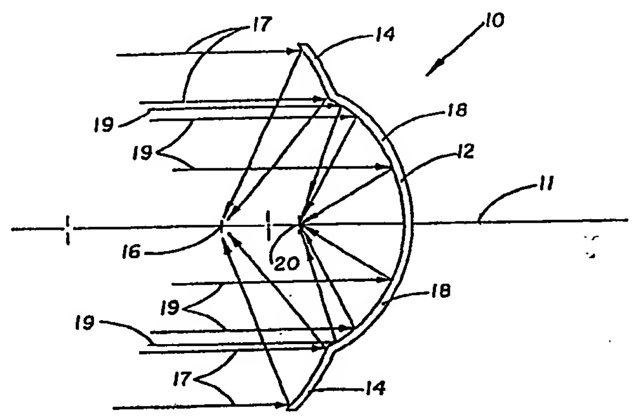

FIG. 1

The drawing(s) originally filed was (were) informal and the print here reproduced is taken from a later filed formal copy.

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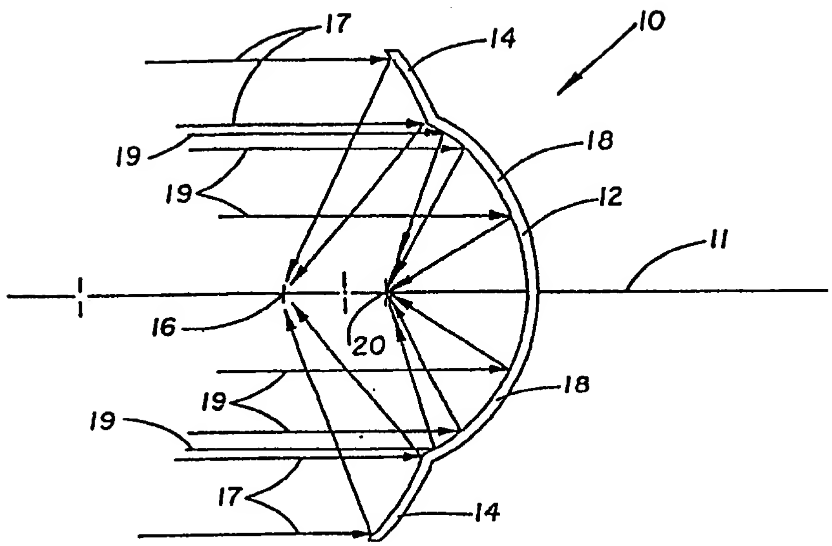

FIG. 1

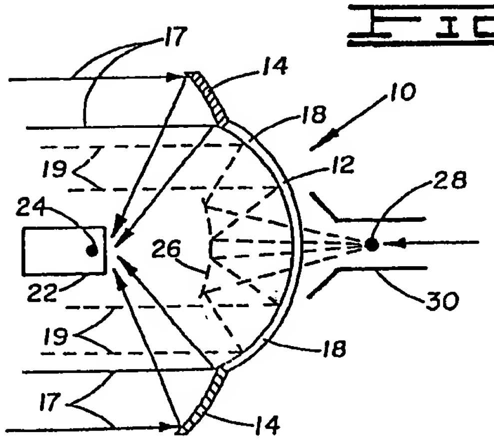

FIG. 2

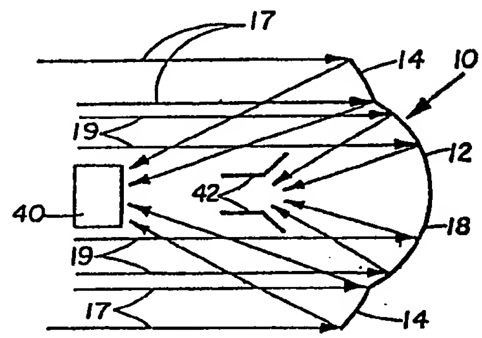

FIG. 3A

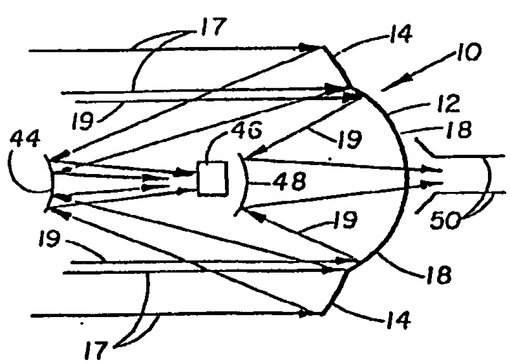

FIG. 3B

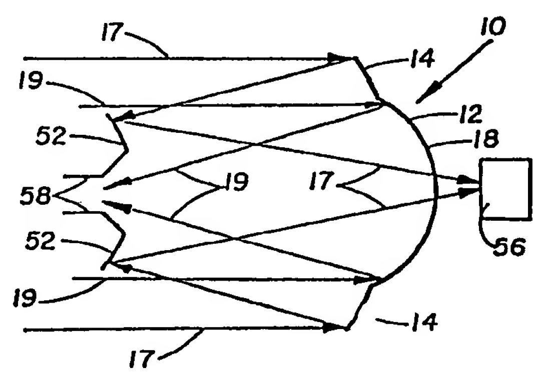

FIG. 3C

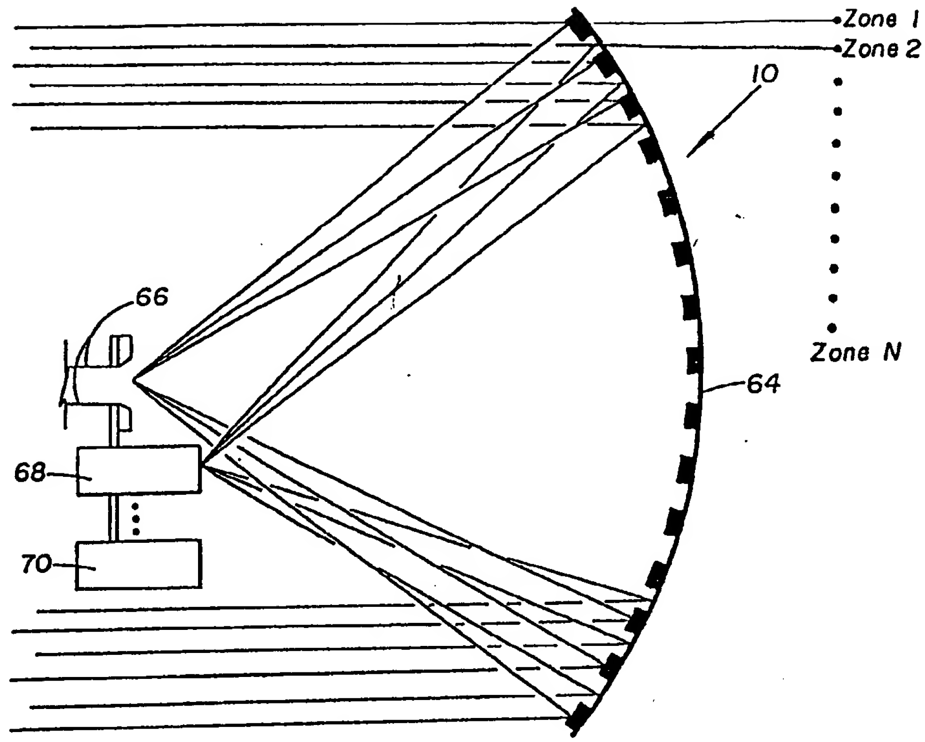

FIG_3E

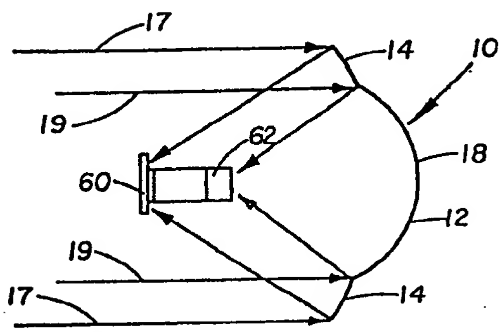

FIG_3D

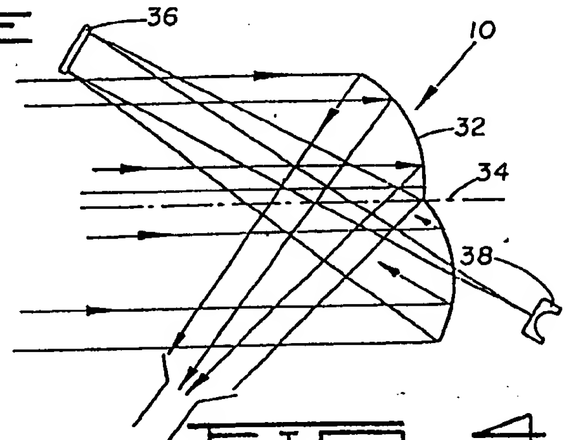

FIG_4

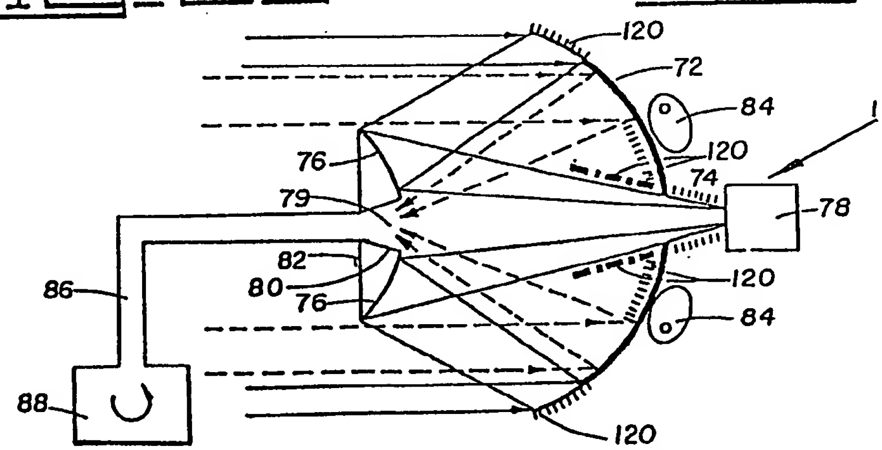

FIG_5

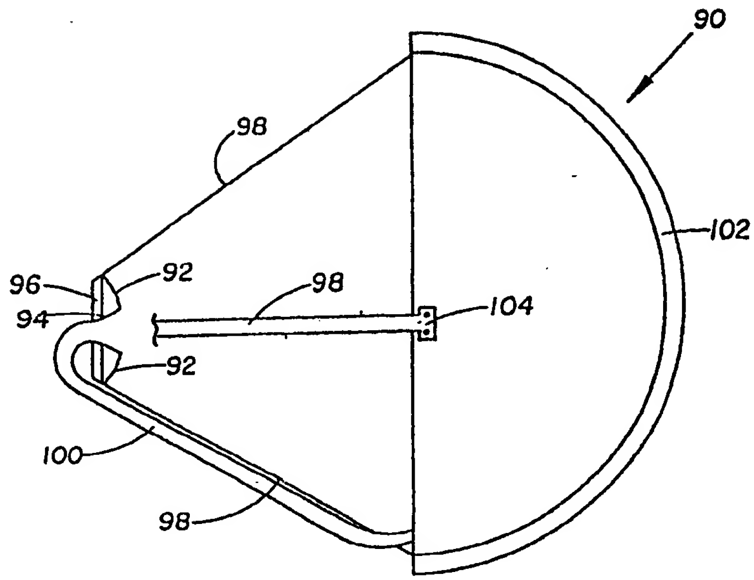
90
98
102
96
92
98
104
94
92
100
98

FIG_6

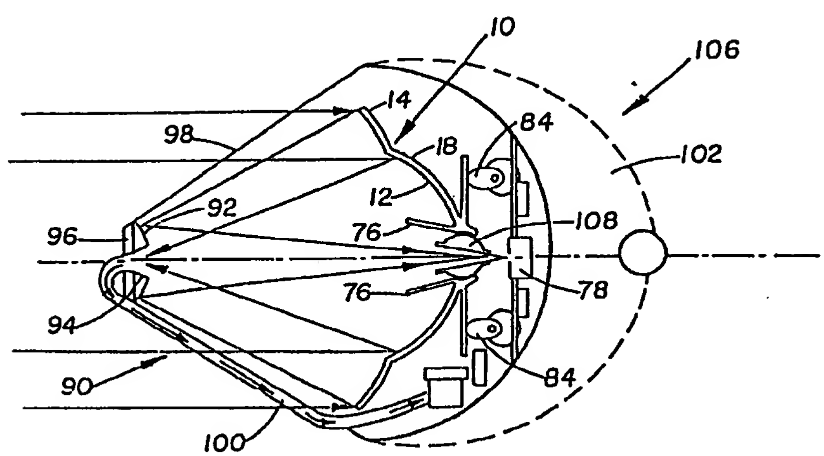
10
106
14
84
98
18
102
12
92
76
108
96
76
78
94
90
84
100

FIG_7

SPECIFICATION

Dual-mode signal separator

Background of the invention

This invention relates to a wavelength signal separator and more particularly, but not by way of limitation, to a dual-mode signal separator for receiving various types of wave signals thereon and separating the signals using different reflector zones having different radii of curvature.

Heretofore, there have been various types of radar and infrared scanning antennas with different types of convex and concave reflectors used in the antennas. These types of antennas and signal separators are described in the following United States patents: U.S. Patent No. 1,906,546 to Darbord; U.S. Patent No. 2,559,092 to Reulos; U.S. Patent No. 2,636,125 to Southworth; U.S. Patent No. 2,702,859 to Robinson; U.S. Patent No. 2,895,127 to Padgett; U.S. Patent No. 3,114,149 to Jessen, Jr.; U.S. Patent No. 3,392,397 to Schwartz; U.S. Patent No. 3,394,378 to Williams et al; U.S. Patent No. 3,500,419 to Leitner et al; U.S. Patent No. 4,282,527 to Winderman et al; U.S. Patent No. 4,348,677 to Salmond, U.S. Patent No. 4,477,814 to Brumbaugh et al. None of the above-mentioned patents provide the unique features and advantages of the subject invention as described herein.

Summary of the invention

The subject dual-mode separator may have any number of zones up to 1, 2, 3.....N. The concept is not limited to concentric rings since the design of the primary reflector can also have zones using concentric spirals, flat segments or surfaces dimpled such as in a golf ball where each dimple represents a small reflector embedded in a substrate. This type of design is particularly suited for "N" different focal lengths and for radio frequency applications where continuous current paths are desired.

The dual-mode separator may be used for ultraviolet, optical, infrared, radio frequency, millimeter and various other types of signal wavelengths. Further, the zoning concept of the separator can be used for off axis reflectors as well as on axis reflectors. Also different anti-reflective or reflective coatings can be used on the surface to reduce cross talk or enhance the surface properties for specific applications.

The dual-mode signal separator for receiving infrared, millimeter radio frequency, ultraviolet and other wave signals thereon includes a primary reflector for receiving signals thereon. The reflector has an optical axis through the center thereof. A first reflector zone is fabricated in the primary reflector. A second reflector z ne is also fabricated in the primary reflector. The first zone has a different radii of curvature from the second zone. The two zones having different focal points along the optical axis of the primary reflector.

Th advantages and objects of th invention will become evident from the following detailed description of th drawings when read in connecti n with the accompanying drawings which illustrate preferred embodiments of the invention.

Brief description of the drawings

Figure 1 illustrates the subject dual-mode signal separator with a zoned primary reflector.

Figure 2 illustrates the primary reflector with a radio frequency horn, a secondary reflector and an infrared detector.

Figure 3A illustrates the primary reflector with an optical detector and radio frequency horn.

Figure 3B illustrates the use of the primary reflector with secondary reflectors for two different zones.

Figure 3C illustrates the use of coalignment of secondary reflectors and a receptor.

Figure 3D illustrates the use of a radio frequency feed and detector with the primary reflector.

Figure 3E illustrates the use of a fresnel zoned reflector with multiple focal parts.

Figure 4 illustrates the use of an off axis zoned reflector.

Figure 5 illustrates the dual-mode signal separator with waveguide millimeter duplexer and infrared detector.

Figure 6 illustrates the use of a spider to support secondary reflectors.

Figure 7 illustrates the dual-mode signal separator integrated into a seeker head.

Detailed description of the drawings

In Figure 1 the dual-mode signal separator is designated by general reference numeral 10 and having a zoned primary reflector 12 with an optical axis 11 through the center of the reflector 12. The reflector 12 includes a first reflector zone 14 and a second reflector zone 18. The first zone 14 has a focal point 16 along the optical axis 11 for focusing signals indicated by arrows 17 thereon. The second zone 18 has a different radii of curvature then the first zone 14 for reflecting signals 19 onto focal point 20.

The multiple focal point zoned primary refléctor 12 as shown in Figure 1 and any alternatives described herein may be fabricated using standard diamond cutting equipment and the like. Also, it may be replicated or molded using compression or injection moulding techniques. Further, to meet particular needs, multiple separator reflection can be used for ultraviolet, optical millimeter, infrared and radio frequency wavelength type systems. The important concepts as described herein is the use of "N" different focal lengths, different length reflectors can be designed, fabricated and integrated such that "N" different secondary reflectors or receptors can be mounted at or relative to individual focal points either on or off the optical axis. Also, it should be noted that the zoning concept as described herein can be used for off axis reflectors as well as on axis reflectors.

In Figure 2, the separator 10 is shown further including an infrared detector 22 for the first zon 14 and having a focal point 24. Also shown in this Figure is a secondary reflector 26 for receiving radio frequency radiation indicated by arrows 19 thereon and reflecting them through the primary refl ctor 12 between a radio frequency horn 30 where it is focussed onto a focal point 28.

The dimensioning of the zon s on the primary reflector 12 has an eff ct on radio frequency pattern

that has important applications. The first of the secondary effects concerns the depth of the different zones. If an infrared zone is cut an average of λ/4 where λ is the wavelength of the radio frequency below the surface of the radio frequency reflector, then the optical reflective surface has no effect on the radio frequency antenna pattern. Also, the desirable distance between zones is λ/10. This can be accomplished by diamond machining. This also shows that the ideal zoned reflector will be a fresnel design with dimensions of each zone a function of the wavelengths, the diameter of the reflector, and the effective surface roughness of the combined surface.

From reviewing Figures 3A through 3D, it is obvious that a wide variety of configurations are possible using the zone primary reflector 12. The zoned primary reflector 12 is equally valid where the primary reflectors are symmetrical or where on axis designs are used. An off axis design variation is shown in Figure 4 wherein an off axis zoned reflector 32 has a centerline 34 with an off axis secondary reflector or detector 36 for focusing on a receptor 38.

Referring back to Figure 3A, the primary reflector 12 is shown with the first zone 14 and second zone 18 focusing the first zone signals 17 on an infrared, ultraviolet or optical detector 40 and with the second zone signals 19 focused between a radio frequency horn 42.

In Figure 3B, a secondary reflector 44 is shown for focusing signals 17 on a receptor 46 with the second zone reflecting signals 19 on a secondary reflector 48 and through the primary reflector 12 and between a radio frequency horn 50.

Figure 3C shows the use of coalignment between secondary reflectors 52 and 54 for reflecting signals 17 from the first zone 14 of the primary reflector 12 onto a receptor 56. The signals 19 are received between a horn 58.

Figure 3D illustrates the variation of using a radio frequency feed 60 for receiving reflected signals 17 from the first zone 14 of the primary reflector 12. Also the signals 19 are reflected from zone 18 onto a detector 62.

Figure 3E illustrates the use of a primary fresnel zoned reflector 64 having Zone 1, Zone 2.......Zone N for multiple focal parts and frequencies for reflecting signals onto a first detector 66, a second detector 68 and onto detector "N" 70 for additional zones.

In Figure 5 the separator 10 includes an infrared primary reflector 72 which may be made of either a solid metal reflective element or a plastic or other radio frequency transparent material. If transparent, the plastic surface is coated with an infrared reflective coating. A back surface 74 of the reflector 72 is coated with a radio frequency absorbent material to reduce energy scatter. A secondary reflector 76 is provided at a location consistent with telescope design. Th reflector 76 reflects infrared energy into an infrared detector 78 located at a focal plane along the optical axis of th telescop . Baffling and abs rbent material 76 is used to minimize the loss in resolution caused by stray light. In a cassegrain telescope, a central porti n 79 of the reflector 76 is normally unused. Therefore, in this portion 79 a feed horn 80 is mounted. The reflector 76 is attached to and aligned by a bracket 82. The feed horn 80 is incorporated into a spider shown in Figure 6. The primary reflector 72 is moved along a horizontal "X" axis by two rotating drive cams 84. The horn 80 is connected to a waveguide 86 which is connected to a millimeter duplexer 88.

In Figure 6 a spider assembly 90 is shown and made up of an infrared secondary reflector 92, a millimeter feedhorn 94 and an alignment bracket 96 attached to a telescope spider legs 98. A radio frequency waveguide 100 can be used and attached to one of the spider legs 98. The spider assembly 90 is rigidly attached to a field of regard seeker head 102 through the use of an adjustable spider attachment 104.

An integrated seeker head assembly 106 is illustrated in Figure 7. In Figure 7 control electronics for the assembly drive and primary reflector 10 is not shown.

The spider assembly 90 is shown with spider legs 98, infrared secondary reflector 92 and millimeter feedhorn 94 all rigidly attached to the seeker head 102 and moving as the head 102 moves.

The zoned primary reflector 12 is attached through a ball joint 108 to the seeker head 102. The seeker head 102 is driven independently from a reflector drive 110 with cams 84. The cams 84 move the reflector 12 within a desired (+) or (−) X degrees in relation to seeker heads centerline. This permits the target area to be scanned in any two dimensional patterns while at the same time the seeker head drive moves the seeker head 102 through a designated motion.

It should be noted from reviewing Figure 7 that the infrared detector 78 is not restricted to any given frequency and may be used for infrared detection, ultraviolet, visible and other frequencies. In addition, the detector 78 can be replaced by a detector array for imaging purposes or to speed up the search rate of the seeker head 102.

CLAIMS

1. A dual-mode signal separator for receiving infrared, millimeter, radio frequency, ultraviolet and other wavelength signals thereon, the separator comprising: a primary reflector for receiving the signals thereon, the reflector having an optical axis through the center thereof; a first reflector zone fabricated in the primary reflector; and a second reflector zone fabricated in the primary reflector, the first zone having a different radii of curvature than the second zone, the two zones having different focal points along the optical axis.

2. The separator as described in Claim 1 wherein the first reflector z ne and second reflector zone may be concentric rings on the primary reflect r or the zones may be concentric spirals, flat segments or dimpled surfaces.

3. The separator as described in Claim 1 further including an infrared detector disposed along the optical axis for receiving reflected signals thereon from the first reflector zone.

4. The separator as described in Claim 1 further including a second reflector disposed along the optical axis for receiving reflected signals thereon from

the second zone and reflecting the signals onto a focal point along the length of the optical axis.

5. The separator as described in Claim 1 further including a radio frequency horn disposed along the optical axis for receiving reflected signals from the second reflector zone.

6. A dual-mode signal separator for receiving infrared, millimeter, radio frequency, ultraviolet and other wavelength signals thereon, the separator comprising: a primary reflector for receiving the signals thereon, the reflector having an optical axis through the center thereof; a first reflector zone fabricated in the primary reflector; a second reflector zone fabricated in the primary reflector, the first zone having a different radii of curvature from the second zone, and two zones having different focal points along the optical axis; an infrared, ultraviolet or optical detector disposed along the optical axis for receiving reflected signals from the first reflector zone; and a second reflector disposed along the length of the optical axis for receiving reflected signals from the second zone and focussing the signals through a radio frequency horn onto a focal point along the optical axis.

7. A dual-mode signal separator substantially as herein described with reference to and as shown in Figures 1, 2, 3A, 3B, 3C, 3D, 3E, 4, 5, 6 or 7 of the accompanying drawings.

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